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June 29, 2012

U.S. Environmental Protection Agency
Region 7 SUPR / MOKS
901 N. 5th Street
Kansas City, Kansas 66101

ATTENTION: Mr. Dan Gravatt

SUBJECT: Sampling and Analysis Plan - Additional Groundwater Monitoring
West Lake Landfill Operable Unit 1, Bridgeton, Missouri
Revised June 22, 2012

Dear Dan,

During a May 10, 2012 conference call, the U.S. Environmental Protection Agency (EPA) asked the West Lake Landfill Operable Unit-1 (OU-1) Respondents to perform an additional round of groundwater sampling at the West Lake Landfill. Engineering Management Support Inc. (EMSI), on behalf of Cotter Corporation (N.S.L.), Bridgeton Landfill, LLC, Rock Road Industries, Inc., and the United States Department of Energy (the OU-1 Respondents), is providing this letter to serve as the Sampling and Analysis Plan (SAP) for that additional groundwater sampling.

EPA has indicated that additional groundwater monitoring is necessary to verify that current groundwater quality is consistent with that characterized during sampling performed in 1995, 1996, and 1997 as part of the Remedial Investigation and in 2004 as part of the Feasibility Study activities for OU-1. This letter describes the relevant project planning documents, proposed monitoring locations, sample collection procedures, analyte list, laboratory analyses, quality assurance/quality control samples and procedures, investigative-derived waste management, health and safety procedures, data evaluation and management procedures, and tentative schedule for the work.

Relevant Project Documents

Prior project planning documents relevant to the proposed groundwater monitoring activities include the following:

- McLaren Hart, 1994, Sampling and Analysis Plan (including Field Sampling Plan and Quality Assurance Project Plan) included as Appendix A to the EPA-approved RI/FS Work Plan, August, 1994.

- EMSI, 1997, Amended Sampling and Analysis Plan, February 1997.

- Herst & Associates, 2003, Letter from Ward Herst (Herst & Associates) to Dan Wall EPA re: Proposed Supplemental Groundwater Sampling, West Lake Landfill Operable Unit 2, November 5, 2003,

- EMSI, 2004, Letter from Paul V. Rosasco (EMSI) to Dan Wall EPA re: Additional Groundwater Monitoring, February 2, 2004.

Copies of the relevant Standard Operating Procedures (SOPs) used by Herst & Associates for groundwater monitoring activities are included with this submittal. A Health and Safety Plan addressing the specific tasks associated with the proposed groundwater monitoring activities is being prepared by Herst & Associates for use by the field crews.

Monitoring Locations

EPA requested that all of the available OU-1 and OU-2 monitoring wells be sampled as part of this effort.

EMSI retained Herst & Associates, Inc. (Herst) to conduct a site inspection and well inventory to ascertain the current number of wells at the site, conditions affecting access to the wells, the condition of the surface portions (protective casing, locks, etc.) of the wells, and the depth to water, total depth and down hole conditions as best as could be determined during collection of depth to water and total depth measurements. The inspection did not include checking whether a pump or other sampling device could be lowered into the wells. Many of the wells are routinely checked by Herst for water levels as part of ongoing groundwater monitoring associated with post-closure care of the permitted solid waste landfill and thus did not need to be re-inspected as part of this effort.

Review of site documents indicated that approximately 115 wells have previously been present at the West Lake site. Figure 1 displays the locations of the various monitoring wells that historically were present at the West Lake Landfill. Table 1 summarizes the current status of the various monitoring wells at the West Lake Landfill. Sixty-eight wells could be located, accessed and appear to be in a condition that is suitable for sampling. Based on the results of the well inspection and review of information obtained during prior sampling activities, it was determined that 35 wells have been abandoned, destroyed, are damaged in a manner that would prevent collection of groundwater samples, or were previously reported as missing. Many (14) of these unavailable wells

were located on property no longer owned by the landfill and subsequently developed by others. The remaining 21 wells were previously reported to have been abandoned, destroyed or lost. The areas around five of the wells that were previously reported to have been abandoned or destroyed were inspected as part of the development of this SAP; however, these inspections failed to locate these wells or any indication that these wells may still exist. Five of the wells were reported (McLaren Hart, 1994) to have been abandoned in October 1992, prior to performance of the Remedial Investigation/ Feasibility Study for OU-1 and OU-2. The areas around three of these wells were inspected and these inspections confirmed that these wells no longer exist. Eight additional wells were previously reported to have been abandoned or destroyed. The areas around these well locations were not inspected. In conjunction with performance of the groundwater sampling, the areas around these wells, and any other wells that were previously reported to have been abandoned/destroyed that were not previously inspected (Table 2), will be inspected to verify that these wells no longer exist. Three wells that were located (S-75, D-87 and MW-103) were determined to have casings that are damaged or obstructed. These three wells will be re-inspected and to the extent practical will be repaired as part of the groundwater sampling effort. The status of the remaining 12 wells could not be determined because the wells could not be located or their locations could not be accessed due to heavy vegetative growth or fencing that restricted access to offsite properties.

Based on the results of the well inspection, it is anticipated that approximately 80 or more wells (68 wells that were inspected and found to be in a condition potentially suitable for sampling plus the additional 12 wells of unknown status plus the three wells found to have damaged casings) listed in Table 3 are proposed for additional groundwater sampling. The locations of these wells are shown on Figure 2.

Prior to conducting the groundwater sampling effort, vegetation must be cleared to allow for access to these wells. Vegetation clearing will be conducted using a skid steer with a ‘brush hog” attachment and/or manually using loppers or a chain saw as necessary.

Although this SAP anticipates that up to 83 groundwater monitoring wells may be sampled, it is possible that additional wells may be located. Alternatively, it is likely that some of the wells may not be located or may not be susceptible to sampling because of constrictions in or damage to the monitoring well casing resulting in a lesser number of wells for sampling. If such constrictions or damage are present in the above grade, or shallow, subsurface portions of the casing, an attempt will be made by the field crew to repair such damage so as to allow for collection of groundwater samples. In addition to the 83 wells listed on Table 2 and shown on Figure 2, any additional wells that can be located during the groundwater monitoring activities and that are found to be, or that can be made to be suitable for groundwater sampling will also be sampled. In any case, the field crew will endeavor to locate and sample as many of the site monitoring wells as possible.

Sample Collection

Samples will be collected from as many of the 83 wells listed in Table 3 that can be accessed and from which samples can be collected. Prior to sample collection, the depth to water and total depth of each well to be sampled will be measured to calculate the volume of standing water in the well casings (casing volume).

A dedicated Waterra (or equivalent) inertial pump (http://www.waterra.com/index.html) consisting of a Waterra D-25, 2-inch diameter, acetal thermoplastic, standard flow (flow rate up to 1 gallon per minute) foot valve connected to high-density, polyethylene tubing will be installed in each monitoring well that does not already possess a bladder or other type of sampling pump. A Waterra compatible surge block (e.g., Waterra SBD-25), or equivalent, may be added to the foot valve to assist with re-development of wells that have not been sampled in many years.

The Waterra pump will be used to purge the standing water from the well prior to sample collection. An automatic actuator may be used to produce the oscillating motion required by the Waterra pump. The volume of water removed from each well will be recorded. Purge water will be containerized at each well during well development activities and subsequently transported to and placed into a polyethylene tank(s).

Field parameters including, at a minimum, temperature, pH, and specific conductance, will be monitored using an in-line flow-through chamber during well purging at a minimum of intervals equivalent to one-half of a well casing volume. Well purging will continue until three successive sets of field parameter readings, obtained at intervals equivalent to successive one-half of a well casing volume, indicate stable water quality: specifically three successive temperature readings within 1 degree C, three successive pH readings within 0.2 pH unit, and three successive specific conductance readings within 10% of each other. A sample for laboratory analysis will then be collected regardless of the number of casing volumes removed. In the event that well stabilization cannot be achieved through continued well purging (e.g., field parameters have not stabilized after removal of five casing volumes), a field decision will be made regarding the need for continued well purging versus collection of a sample.

In the case of monitoring wells, if any, that are dewatered during well purging, the water level in the subject well will be allowed to recover for 24 hours at which time a sample will be collected. In the event that the water level in a well does not recover sufficiently within 24 hours, the well will continue to be checked periodically during the groundwater sampling activities for the presence of water. If the water level recovers sufficiently to allow for sample collection prior to completion of the groundwater monitoring activities, a sample will be collected from that well. In order to insure that the most important sample fractions are obtained, the order of sample fraction collection will be prioritized as follows: total radio-isotopes sample containers first, dissolved radio-isotopes sample containers second, volatile organic compound (VOC) sample containers third, total trace

metal sample containers fourth, and dissolved metal sample containers fifth. In the event that a low producing well is selected by EPA and/or MDNR for collection of split samples, the same priority for sample fraction collection will be used with the additional criteria that the radio-isotope sample bottles for the investigative samples to be obtained by Herst & Associates on behalf of EMSI will be filled first followed by the radio-isotope bottles for the split samples to be obtained by EPA or MDNR. Collection of samples for additional analytical fractions (e.g., VOCs) will subsequently be conducted using the same prioritization.

Upon completion of sample collection, the well tubing will be pushed down inside the well and trimmed as necessary to allow for placement of the well cap and securing of the protective casing. If necessary to facilitate subsequent access to the pump tubing, a short length of rope may be secured to the top of the pump tubing with the other end of the rope secured around the inner casing, to the well cap or to the outer casing as determined by the field crew.

Groundwater samples collected for laboratory analysis will placed in the appropriate pre-preserved bottles provided by the analytical laboratories. Samples to be analyzed for dissolved trace metals and radionuclides will be subjected to field filtering prior to placement in the pre-preserved sample bottles.

Chain-of-custody forms will be completed in the field by the sampling crew to document the names of the samplers, the actual samples collected by the sampling crew, the date and time of sample collection, the number and types of sample containers obtained from each well sampled, the type of preservation performed on each sample container, and the requested laboratory analyses. Chain-of-custody forms will be completed for each analytical laboratory used for the groundwater monitoring effort.

Laboratory Analyses

The collected samples will be analyzed for uranium (U-238, U-235 and U-234), radium (Ra-226 and Ra-228) and thorium (Th-232, Th-230 and Th-228) isotopes, EPA Target Compund List (TCL) trace metals, TCL volatile organic compounds (VOCs), and TCL semivolatile organic compounds (SVOCs) (please see http://www.epa.gov/superfund/programs/clp/target.htm for a list of TCL parameters). Radionuclide and trace metal samples will be analyzed for both dissolved (field filtered samples) and total (unfiltered samples) concentrations.

Radionuclide analyses will be performed by Eberline Laboratory of Oak Ridge, Tennessee. All other analyses will be performed by Test America, either at its Earth City, Missouri laboratory or one of the other Test America laboratories depending upon laboratory capabilities and schedules at the time of sample delivery. Samples to be analyzed by Eberline will be shipped via overnight courier to the Eberline Laboratory in Oak Ridge, Tennessee. Samples to be analyzed by Test America will be delivered

directly to Test America's Earth City laboratory for analysis there or shipment via overnight courier to another Test America laboratory, if necessary.

The samples will be analyzed using the following laboratory methods:

Analytes	Analytical Method
Thorium isotopes	EML Th-01
Uranium isotopes	EML U-02
Radium-226	EPA 903.0 (Modified to Alpha Spectroscopy)
Radium-228	EPA 904.0
Trace metals	SW-846 6020
Volatile organic compounds	SW-846 8260B
Semi-volatile organic compounds	SW-846 8270C

Quality Assurance/Quality Control

The following quality assurance/quality control samples will be obtained in the field:

- Field duplicate samples – one duplicate sample per every ten investigative samples (duplicate samples will include duplicate sample bottles for all sample analytical fractions);
- VOC trip blanks – one sample per every sample container (e.g., cooler) delivered to the laboratory that contains samples for VOC analyses; and
- VOC, SVOC and trace metal matrix spike and matrix spike duplicate samples – one of each for every twenty investigative samples.

Additional quality assurance/quality control samples such as method blank samples, laboratory duplicate samples, laboratory control samples, surrogate spike samples, matrix spike and matrix spike duplicate samples will be prepared and analyzed by the analytical laboratories in accordance with the requirements of the analytical methods listed above and the laboratory's standard operating procedures.

Investigative Derived Materials

Purge water from each monitoring well will be containerized and subsequently transported to and placed into a polyethylene tank(s). Upon completion of the

groundwater sampling activities, a sample(s) will be obtained from the tank(s) and analyzed for the same analyses as used for the investigative samples plus any additional parameters required by the anticipated disposal facility(ies). It is anticipated that subject to the results of the analyses, the purge water will be collected and disposed by Heritage Environmental Services and/or discharge to the sewer system if approved by the Metropolitan Sewer District (MSD).

Solid waste generated during the sampling activities, including but not limited to well tubing remnants, paper towels, and used gloves will be disposed of at the solid waste transfer facility on site.

Health and Safety

Brush clearing and groundwater sampling activities will be performed by Herst & Associates personnel that have been trained in health and safety procedures for Hazardous Waste Operations and Emergency Response (HAZWOPER). Herst & Associates will prepare a Health and Safety Plan (HSP) that addresses the specific activities to be conducted in conjunction with the groundwater monitoring effort. A copy of the HSP will be provided for information purposes only to all personnel that are present on site in conjunction with the groundwater sampling activities; however, each organization will be responsible for developing and implementing the health and safety procedures necessary for its own personnel. Herst & Associates and EMSI will not be responsible for the health and safety of any personnel other than their own employees.

Data Evaluation and Management

The analytical data will be subject to data validation in accordance with the requirements of the most recent EPA data validation procedure for each analyte group. All of the data will be subject to a Level III data validation plus checks on the laboratory instrument calibration, continuing calibration verification, and internal standards. Based on the results of the data validation effort, additional data qualifiers beyond those applied by the laboratories may be required for the analytical data. A data validation report will be prepared documenting the results of the data validation effort.

The results of the additional groundwater monitoring will be tabulated separately and in conjunction with the results obtained during the RI sampling conducted in 1995, 1996 and 1997 and the FS sampling conducted in 2004. A brief report describing the sampling activities will be prepared and will include the analytical data summary tables described above, the well sampling and purging forms, chain of custody reports, the analytical laboratory reports, and the data validation reports.

Anticipated Schedule of Activities

One round of groundwater sampling will be performed. Brush clearing activities to provide physical access to the monitoring wells will be scheduled upon receipt of EPA approval of this SAP. Allowing for scheduling and mobilization of vegetation clearing crew, it is anticipated that it will take one to two weeks to complete the brush clearing activities. Groundwater sampling will be initiated within one week of completion of the brush clearing activities. Based on an assumed sample collection rate of five samples per day, it is anticipated that it will take three to four weeks to collect groundwater samples from the approximately 80 wells to be sampled as part of this effort. It is anticipated that it will take approximately three to four weeks for laboratory analyses of the samples. Data validation will take approximately four weeks and data evaluation and report preparation will take another two weeks. Consequently, the total estimated duration of the activities from EPA approval of this SAP until submittal of a sampling report is estimated to be approximately fourteen to seventeen weeks.

If you have any questions or desire additional information related to this SAP or any other aspect of the project, please do not hesitate to contact me.

Sincerely,
ENGINEERING MANAGEMENT SUPPORT, Inc.

Paul V. Rosasco, P.E.

Attachments:

Table 1 – List of Existing and Abandoned Monitoring Wells
Table 2 – Reported Abandoned/Destroyed Monitoring Wells to be Inspected
Table 3 – List of Monitoring Wells Potentially Available for Sampling

Figure 1 – Current and Prior Groundwater Monitoring Wells
Figure 2 – Groundwater Monitoring Wells Potentially Suitable for Additional Groundwater Sampling

Herst & Associates Standard Operating Procedures

Distribution:

Shawn Muenks – Missouri Department of Natural Resources
Jessica Merrigan – Lathrop & Gage
Kate Whitby – Spencer Fane Britt & Browne
Victoria Warren – Republic Services, Inc.
Charlotte Neitzel – Bryan Cave HRO
Steve Golian - U. S. Department of Energy
Ward Herst - Herst & Associates, Inc.

TABLES

Table 1: List of Existing and Abandoned Monitoring Wells by Well Number, West Lake Landfill OU-1 and OU-2

Well Number	General Location	Inspected?	Condition
S-1	Radiological Area 2	No - area overgrown	Unknown
S-5	Radiological Area 1	Yes	Okay
S-8	Radiological Area 2	No - area overgrown	Unknown
S-10	Radiological Area 2	Yes	Okay
S-51	Closed Leachate Pond	No	Destroyed/Abandoned
S-52	Closed Leachate Pond	No	Destroyed/Abandoned
S-53	Closed Leachate Pond	No	Destroyed/Abandoned
S-54	Inactive Landfill	No	Abandoned 10/92
S-61	Radiological Area 2	Yes	Okay
S-75	Inactive Landfill	Yes	Casing damaged/obstructed
S-76	Inactive Landfill	No	Abandoned 10/92
S-80	Upgradient	No	Destroyed/Abandoned
S-82	Radiological Area 2	Yes	Okay
S-84	Radiological Area 1	Yes	Okay
S-88	Inactive Landfill	Yes	Destroyed/Abandoned
I-2	Radiological Area 2	No - area overgrown	Unknown-unable to locate previously
I-4	Radiological Area 1	Yes	Okay
I-7	Radiological Area 2	No - area overgrown	Unknown
I-9	Radiological Area 2	Yes	Okay - may be incorrectly labelled
I-11	Radiological Area 2	Yes	Okay
I-50	Upgradient	No	Destroyed/Abandoned
I-56	Inactive Landfill	Yes	Abandoned 10/92
I-58	Inactive Landfill	Yes	Abandoned 10/92
I-59	Radiological Area 2	Yes	Abandoned 10/92
I-62	Radiological Area 2	No - area overgrown	Unknown
I-65	Radiological Area 2	No - area overgrown	Unknown
I-66	Radiological Area 2	Yes	Okay
I-67	Closed Demolition Landfill	Yes	Okay
I-68	Radiological Area 1	Yes	Okay
I-72	Concrete/Asphalt Plants	No	Destroyed/Abandoned
I-73	Concrete/Asphalt Plants	Yes	Okay
D-3	Radiological Area 1	Yes	Okay
D-6	Radiological Area 2	Yes	Okay
D-12	Radiological Area 2	Yes	Okay
D-13	Radiological Area 2	Yes	Okay
D-14	Radiological Area 1	No	Destroyed/Abandoned
D-81	Inactive Landfill	No - area overgrown	Unknown
D-83	Radiological Area 2	No - area overgrown	Unknown
D-85	Radiological Area 1	Yes	Okay
D-87	Closed Demolition Landfill	Yes	Casing obstructed
D-89	Inactive Landfill	No	Destroyed/Abandoned
D-90	Upgradient	No	Reported as missing in 1994
D-91	Upgradient	No	Reported as missing in 1994
D-92	Closed Demolition Landfill	Yes	Destroyed/Abandoned
D-93	Radiological Area 2	Yes	Okay - may be incorrectly labelled

Table 1: List of Existing and Abandoned Monitoring Wells by Well Number, West Lake Landfill OU-1 and OU-2

Well Number	General Location	Inspected?	Condition
D-94	Radiological Area 2	No - area overgrown	Unknown - previous report - damaged
LR-100	Inactive Landfill	Yes	Destroyed/Abandoned
LR-101	Inactive Landfill	Yes	Destroyed/Abandoned
LR-102	Inactive Landfill	Yes	Unknown - beneath soil stockpile
LR-103	Inactive Landfill	Yes	Okay
LR-104	Concrete/Asphalt Plants	Yes	Okay
LR-105	Inactive Landfill	Yes	Okay
MW-101	Radiological Area 2	No - area overgrown	Unknown
MW-102	Radiological Area 2	Yes	Okay
MW-103	Inactive Landfill	Yes	Casing damaged/obstructed
MW-104	Inactive Landfill	Yes	Okay
MW-105	Earth City	No	Destroyed/Abandoned
MW-106	Upgradient	No	Destroyed/Abandoned
MW-107	Upgradient	No	Destroyed/Abandoned
MW-1204	South Quarry	Yes	Okay
MW-1205	unknown	No	Abandoned/decomissioned
MW-1206	unknown	No	Abandoned/decomissioned
MW-F1D	North Quarry	No	Destroyed/Abandoned
MW-F1S	North Quarry	No	Destroyed/Abandoned
MW-F2	Inactive Landfill	Yes	Destroyed/Abandoned
MW-F3	Radiological Area 2	No	Destroyed/Abandoned
PZ-100-SD*	North Quarry	Yes	Okay
PZ-100-SS*	North Quarry	Yes	Okay
PZ-100-KS	North Quarry	Yes	Okay
PZ-101-SS	North Quarry	Yes	Okay
PZ-102-SS	North Quarry	Yes	Okay
PZ-102R-SS	North Quarry	Yes	Okay
PZ-103-SS	South Quarry	Yes	Okay
PZ-104-SD*	South Quarry	Yes	Okay
PZ-104-SS*	South Quarry	Yes	Okay
PZ-104-KS	South Quarry	Yes	Okay
PZ-105-SS*	South Quarry	Yes	Okay
PZ-106-SD*	South Quarry	Yes	Okay
PZ-106-SS*	South Quarry	Yes	Okay
PZ-106-KS	South Quarry	Yes	Okay
PZ-107-SS	Inactive Landfill	Yes	Okay
PZ-108-SS*	South Quarry	Yes	Okay
PZ-109-SS*	South Quarry	Yes	Okay
PZ-110-SS*	North Quarry	Yes	Okay
PZ-111-SD*	North Quarry	Yes	Okay
PZ-111-KS	North Quarry	Yes	Okay
PZ-112-AS	Radiological Area 1	Yes	Okay
PZ-113-AD	Closed Demolition Landfill	Yes	Okay
PZ-113-AS	Closed Demolition Landfill	Yes	Okay
PZ-113-SS	Closed Demolition Landfill	Yes	Okay

Table 1: List of Existing and Abandoned Monitoring Wells by Well Number, West Lake Landfill OU-1 and OU-2

Well Number	General Location	Inspected?	Condition
PZ-114-AS*	North Quarry	Yes	Okay
PZ-115-SS*	North Quarry	Yes	Okay
PZ-116-SS	South Quarry	Yes	Okay
PZ-200-SS	North Quarry	Yes	Okay
PZ-201A-SS*	South Quarry	Yes	Okay
PZ-202-SS	South Quarry	Yes	Okay
PZ-203-SS	South Quarry	Yes	Okay
PZ-204-SS	South Quarry	Yes	Okay
PZ-204A-SS	South Quarry	Yes	Okay
PZ-205-AS	South Quarry	Yes	Okay
PZ-205-SS*	South Quarry	Yes	Okay
PZ-206-SS	Concrete/Asphalt Plants	Yes	Okay
PZ-207-AS	Closed Demolition Landfill	Yes	Okay
PZ-208-SS	North Quarry	Yes	Okay
PZ-300-AS	Upgradient	No	Destroyed/Abandoned
PZ-300-AD	Upgradient	No	Destroyed/Abandoned
PZ-300-SS	Upgradient	No	Destroyed/Abandoned
PZ-301-SS	Upgradient	No	Destroyed/Abandoned
PZ-302-AI	Inactive Landfill	Yes	Okay
PZ-302-AS	Inactive Landfill	Yes	Okay
PZ-303-AS	Inactive Landfill	Yes	Okay
PZ-304-AI	Inactive Landfill	Yes	Okay
PZ-304-AS	Inactive Landfill	Yes	Okay
PZ-305-AI	Concrete/Asphalt Plants	Yes	Okay
PZ-1201-SS	South Quarry	Yes	Unknown - location buried beneath soil

* Included in monitoring program for the permitted solid waste landfill.

Table 2: Reported Abandoned/Destroyed Monitoring Wells to be Inspected, West Lake Landfill OU-1 and OU-2

Well Number	General Location	Inspected?	Condition
S-1	Radiological Area 2	No - area overgrown	Unknown - need to clear vegetation
S-51	Closed Leachate Pond	No	Destroyed/Abandoned
S-52	Closed Leachate Pond	No	Destroyed/Abandoned
S-53	Closed Leachate Pond	No	Destroyed/Abandoned
S-54	Inactive Landfill	No	Abandoned 10/92
S-76	Inactive Landfill	No	Abandoned 10/92
S-8	Radiological Area 2	No - area overgrown	Unknown - need to clear vegetation
S-80	Upgradient	No	Destroyed/Abandoned
S-88	Inactive Landfill	Yes	Destroyed/Abandoned
I-2	Radiological Area 2	No - area overgrown	Unknown-unable to locate previously
I-50	Upgradient	No	Destroyed/Abandoned
I-56	Inactive Landfill	Yes	Abandoned 10/92
I-58	Inactive Landfill	Yes	Abandoned 10/92
I-59	Radiological Area 2	Yes	Abandoned 10/92
I-62	Radiological Area 2	No - area overgrown	Unknown - need to clear vegetation
I-65	Radiological Area 2	No - area overgrown	Unknown - need to clear vegetation
I-7	Radiological Area 2	No - area overgrown	Unknown - need to clear vegetation
I-72	Concrete/Asphalt Plants	No	Destroyed/Abandoned
D-14	Radiological Area 1	No	Destroyed/Abandoned
D-81	Inactive Landfill	No - area overgrown	Unknown - need to clear vegetation
D-83	Radiological Area 2	No - area overgrown	Unknown - need to clear vegetation
D-89	Inactive Landfill	No	Destroyed/Abandoned
D-90	Upgradient	No	Reported as missing in 1994
D-91	Upgradient	No	Reported as missing in 1994
D-92	Closed Demolition Landfill	Yes	Destroyed/Abandoned
D-94	Radiological Area 2	No - area overgrown	Unknown - previous report - damaged
LR-100	Inactive Landfill	Yes	Destroyed/Abandoned
LR-101	Inactive Landfill	Yes	Destroyed/Abandoned
LR-102	Inactive Landfill	Yes	Unknown - beneath soil stockpile
MW-101	Radiological Area 2	No - area overgrown	Unknown - need to clear vegetation
MW-105	Earth City	No	Destroyed/Abandoned
MW-106	Upgradient	No	Destroyed/Abandoned
MW-107	Upgradient	No	Destroyed/Abandoned
MW-1205	unknown	No	Abandoned/decomissioned
MW-1206	unknown	No	Abandoned/decomissioned
MW-F1D	North Quarry	No	Destroyed/Abandoned
MW-F1S	North Quarry	No	Destroyed/Abandoned
MW-F2	Inactive Landfill	Yes	Destroyed/Abandoned
MW-F3	Radiological Area 2	No	Destroyed/Abandoned
PZ-1201-SS	South Quarry	Yes	Unknown - location buried beneath soil
PZ-300-AD	Upgradient	No	Destroyed/Abandoned
PZ-300-AS	Upgradient	No	Destroyed/Abandoned
PZ-300-SS	Upgradient	No	Destroyed/Abandoned
PZ-301-SS	Upgradient	No	Destroyed/Abandoned

Table 3: List of Monitoring Wells Potentially Available for Sampling, West Lake Landfill OU-1 and OU-2

Well Number	General Location	Inspected?	Condition
D-12	Radiological Area 2	Yes	Okay
D-13	Radiological Area 2	Yes	Okay
D-3	Radiological Area 1	Yes	Okay
D-6	Radiological Area 2	Yes	Okay
D-85	Radiological Area 1	Yes	Okay
I-11	Radiological Area 2	Yes	Okay
I-4	Radiological Area 1	Yes	Okay
I-66	Radiological Area 2	Yes	Okay
I-67	Closed Demolition Landfill	Yes	Okay
I-68	Radiological Area 1	Yes	Okay
I-73	Concrete/Asphalt Plants	Yes	Okay
LR-103	Inactive Landfill	Yes	Okay
LR-104	Concrete/Asphalt Plants	Yes	Okay
LR-105	Inactive Landfill	Yes	Okay
MW-102	Radiological Area 2	Yes	Okay
MW-104	Inactive Landfill	Yes	Okay
MW-1204	South Quarry	Yes	Okay
PZ-100-KS	North Quarry	Yes	Okay
PZ-100-SD*	North Quarry	Yes	Okay
PZ-100-SS*	North Quarry	Yes	Okay
PZ-101-SS	North Quarry	Yes	Okay
PZ-102R-SS	North Quarry	Yes	Okay
PZ-102-SS	North Quarry	Yes	Okay
PZ-103-SS	South Quarry	Yes	Okay
PZ-104-KS	South Quarry	Yes	Okay
PZ-104-SD*	South Quarry	Yes	Okay
PZ-104-SS*	South Quarry	Yes	Okay
PZ-105-SS*	South Quarry	Yes	Okay
PZ-106-KS	South Quarry	Yes	Okay
PZ-106-SD*	South Quarry	Yes	Okay
PZ-106-SS*	South Quarry	Yes	Okay
PZ-107-SS	Inactive Landfill	Yes	Okay
PZ-108-SS*	South Quarry	Yes	Okay
PZ-109-SS*	South Quarry	Yes	Okay
PZ-110-SS*	North Quarry	Yes	Okay
PZ-111-KS	North Quarry	Yes	Okay
PZ-111-SD*	North Quarry	Yes	Okay
PZ-112-AS	Radiological Area 1	Yes	Okay
PZ-113-AD	Closed Demolition Landfill	Yes	Okay
PZ-113-AS	Closed Demolition Landfill	Yes	Okay
PZ-113-SS	Closed Demolition Landfill	Yes	Okay
PZ-114-AS*	North Quarry	Yes	Okay
PZ-115-SS*	North Quarry	Yes	Okay
PZ-116-SS	South Quarry	Yes	Okay
PZ-200-SS	North Quarry	Yes	Okay

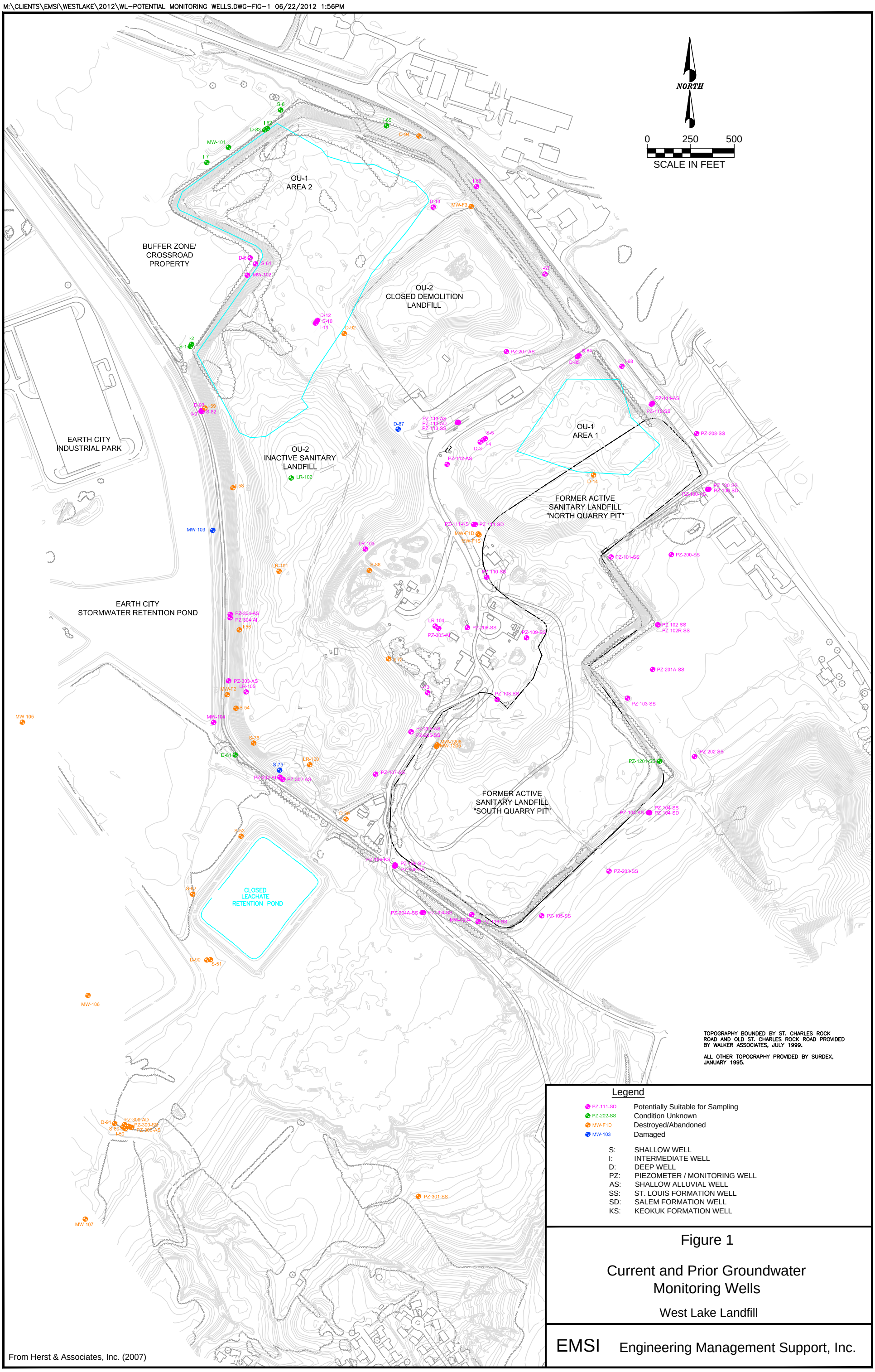
Table 3: List of Monitoring Wells Potentially Available for Sampling, West Lake Landfill OU-1 and OU-2

Well Number	General Location	Inspected?	Condition
PZ-201A-SS*	South Quarry	Yes	Okay
PZ-202-SS	South Quarry	Yes	Okay
PZ-203-SS	South Quarry	Yes	Okay
PZ-204A-SS	South Quarry	Yes	Okay
PZ-204-SS	South Quarry	Yes	Okay
PZ-205-AS	South Quarry	Yes	Okay
PZ-205-SS*	South Quarry	Yes	Okay
PZ-206-SS	Concrete/Asphalt Plants	Yes	Okay
PZ-207-AS	Closed Demolition Landfill	Yes	Okay
PZ-208-SS	North Quarry	Yes	Okay
PZ-302-AI	Inactive Landfill	Yes	Okay
PZ-302-AS	Inactive Landfill	Yes	Okay
PZ-303-AS	Inactive Landfill	Yes	Okay
PZ-304-AI	Inactive Landfill	Yes	Okay
PZ-304-AS	Inactive Landfill	Yes	Okay
PZ-305-AI	Concrete/Asphalt Plants	Yes	Okay
S-10	Radiological Area 2	Yes	Okay
S-5	Radiological Area 1	Yes	Okay
S-61	Radiological Area 2	Yes	Okay
S-82	Radiological Area 2	Yes	Okay
S-84	Radiological Area 1	Yes	Okay
D-93	Radiological Area 2	Yes	Okay - may be incorrectly labelled
I-9	Radiological Area 2	Yes	Okay - may be incorrectly labelled
D-81	Inactive Landfill	No - area overgrown	Unknown
D-83	Radiological Area 2	No - area overgrown	Unknown
I-62	Radiological Area 2	No - area overgrown	Unknown
I-65	Radiological Area 2	No - area overgrown	Unknown
I-7	Radiological Area 2	No - area overgrown	Unknown
MW-101	Radiological Area 2	No - area overgrown	Unknown
S-1	Radiological Area 2	No - area overgrown	Unknown
S-8	Radiological Area 2	No - area overgrown	Unknown
LR-102	Inactive Landfill	Yes	Unknown - beneath soil stockpile
PZ-1201-SS	South Quarry	Yes	Unknown - buried beneath soil
D-94	Radiological Area 2	No - area overgrown	Unknown-previous report - damaged
I-2	Radiological Area 2	No - area overgrown	Unknown-unable to locate previously
S-75	Inactive Landfill	Yes	Casing damaged/obstructed
D-87	Closed Demolition Landfill	Yes	Casing obstructed
MW-103	Inactive Landfill	Yes	Casing damaged/obstructed

* Included in monitoring program for the permitted solid waste landfill.

FIGURES

M:\CLIENTS\EMSI\WESTLAKE\2012\WL-POTENTIAL MONITORING WELLS.DWG-FIG-1 06/22/2012 1:56PM



TOPOGRAPHY BOUNDED BY ST. CHARLES ROCK ROAD AND OLD ST. CHARLES ROCK ROAD PROVIDED BY WALKER ASSOCIATES, JULY 1999.

ALL OTHER TOPOGRAPHY PROVIDED BY SURDEX, JANUARY 1995.

Legend

PZ-111-SD	Potentially Suitable for Sampling
PZ-202-SS	Condition Unknown
MW-F1D	Destroyed/Abandoned
MW-103	Damaged

S:	SHALLOW WELL
I:	INTERMEDIATE WELL
D:	DEEP WELL
PZ:	PIEZOMETER / MONITORING WELL
AS:	SHALLOW ALLUVIAL WELL
SS:	ST. LOUIS FORMATION WELL
SD:	SALEM FORMATION WELL
KS:	KEOKUK FORMATION WELL

Figure 1

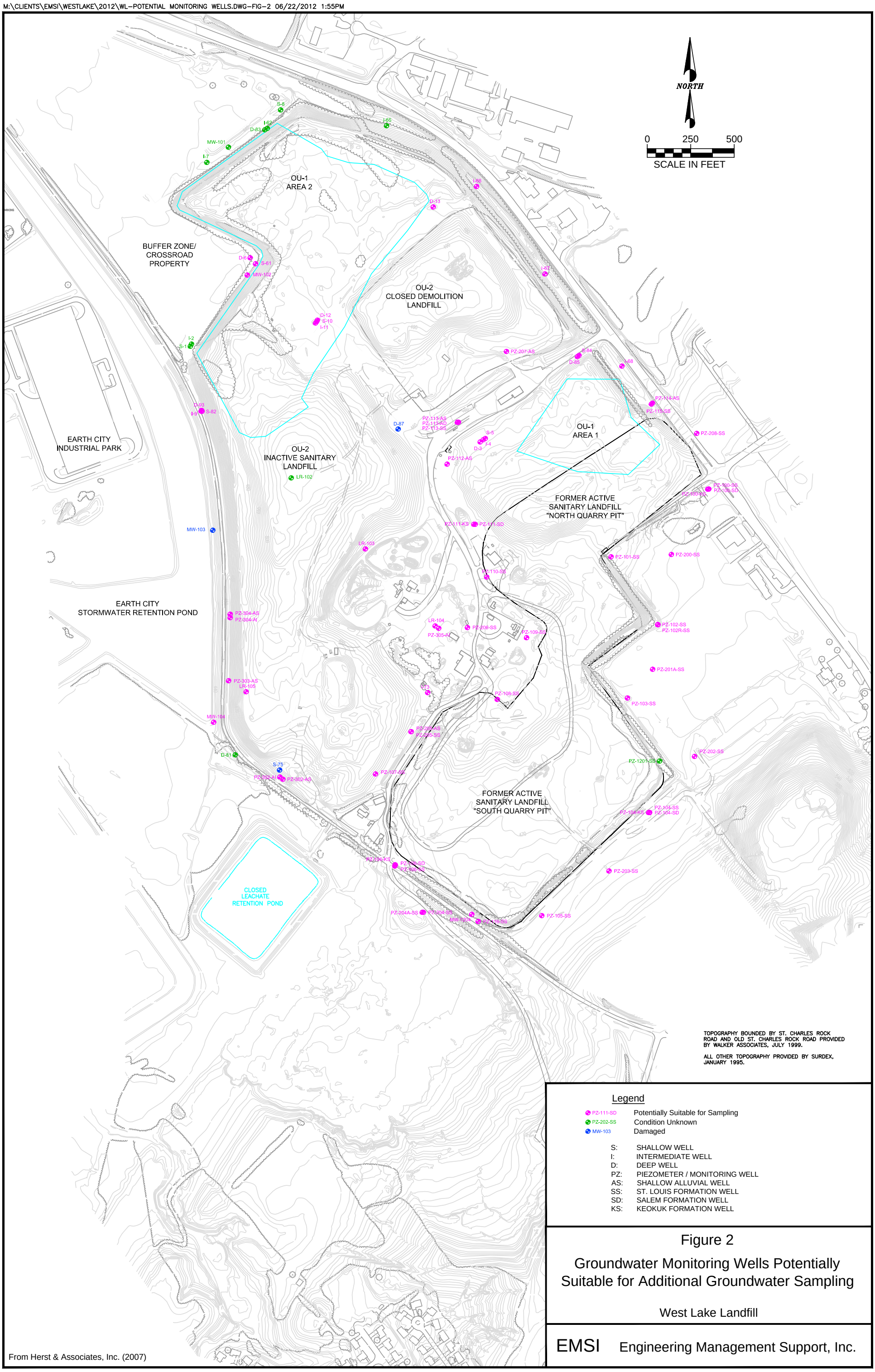
Current and Prior Groundwater Monitoring Wells

West Lake Landfill

EMSI Engineering Management Support, Inc.

From Herst & Associates, Inc. (2007)

M:\CLIENTS\EMSI\WESTLAKE\2012\WL-POTENTIAL MONITORING WELLS.DWG-FIG-2 06/22/2012 1:55PM



TOPOGRAPHY BOUNDED BY ST. CHARLES ROCK ROAD AND OLD ST. CHARLES ROCK ROAD PROVIDED BY WALKER ASSOCIATES, JULY 1999.

ALL OTHER TOPOGRAPHY PROVIDED BY SURDEX, JANUARY 1995.

From Herst & Associates, Inc. (2007)

Legend

PZ-111-SD	Potentially Suitable for Sampling
PZ-202-SS	Condition Unknown
MW-103	Damaged

S:	SHALLOW WELL
I:	INTERMEDIATE WELL
D:	DEEP WELL
PZ:	PIEZOMETER / MONITORING WELL
AS:	SHALLOW ALLUVIAL WELL
SS:	ST. LOUIS FORMATION WELL
SD:	SALEM FORMATION WELL
KS:	KEOKUK FORMATION WELL

Figure 2

Groundwater Monitoring Wells Potentially Suitable for Additional Groundwater Sampling

West Lake Landfill

EMSI Engineering Management Support, Inc.

STANDARD OPERATING PROCEDURES

Standard Operating Procedures for Groundwater Sample Collection

Herst & Associates, Inc.
SOP – GW
Revision 4.2

Revised
June 25, 2012

HERST & ASSOCIATES, INC.®

4631 North St. Peters Parkway
St. Charles, Missouri 63304
Telephone: (636) 939-9111
Facsimile: (636) 939-9757

TABLE OF CONTENTS

LIST OF APPENDICES

1.0 INTRODUCTION

The following guidelines describe groundwater sample collection and handling procedures for the Herst & Associates, Inc. personnel. The intent of the Standard Operating Procedures described herein is to provide procedures designed to yield representative and comparable analytical data from each site during each sampling event.

There are three (3) principal steps in collecting groundwater samples from monitoring wells:

- Measuring static groundwater levels;
- Evacuating or purging well casings; and
- Collecting and preserving samples.

These steps are discussed more completely below.

2.0 STATIC GROUNDWATER LEVEL, MONITORING WELL DEPTH, AND MONITORING WELL VOLUME

2.1 Facility-Wide Depth to Groundwater Measurements

Static depths to groundwater and total depths will be measured at applicable facility monitoring wells and piezometers on the same day, if possible, and prior to purging and sampling of monitoring wells during each monitoring event. Depths to static groundwater levels will be measured from the surveyed mark at the top of the inner casing of each monitoring well. If there is no surveyed mark available at the top of the inner casing, the measurement will be performed on the same side as of the well as the lock on the exterior protective casing. Measurements of depth to groundwater and measurements of total monitoring well depth will be performed with an electronic water level indicator that is graduated in increments of one one-hundredth (1/100) of a foot and provides an audible and visual indication of water contact. Each measurement for depth to groundwater and each measurement for total depth will be performed twice (double-checked) to minimize the potential for false readings. Parts of water level measuring devices that contact groundwater will be thoroughly washed with a non-phosphate detergent (e.g. LiquiNox® or equivalent) followed by a rinse with deionized water or distilled water immediately after each use to minimize the potential for cross-contamination of monitoring wells.

Results of the facility-wide measurements of depth to groundwater will subsequently be used for generation of a potentiometric surface map for the monitoring event. The groundwater elevation in each monitoring well will be determined by subtracting the measured depth to groundwater from the top-of-inner-casing elevation. **Appendix A** presents an example Groundwater Elevation Measurements form. Additionally, while measuring facility-wide static groundwater depths, Herst & Associates, Inc. personnel will perform an evaluation of each monitoring well and piezometer and record the results of each evaluation on a Monitoring Well Condition Report. **Appendix B** presents an example Monitoring Well Condition Report.

2.2 Monitoring Well Casing Volume Determination

The depth to groundwater will be measured immediately prior to monitoring well purging in order to calculate each well's initial groundwater volume. The difference between the measured total monitoring well depth and depth to static groundwater level is the stabilized height of the groundwater column in the monitoring well. These measurements, taken from the same location on the inner casing described in Section 2.1 during each sampling event, will be used to determine the static monitoring well volume (in gallons) of groundwater in each well per the two (2)-step method described below.

1) The height (H) of the groundwater column is determined by measuring the total depth (TD) of the well and subtracting the measured depth to static water level (MSD).

$$H \text{ (feet)} = TD \text{ (feet)} – MSD \text{ (feet)}$$

2) Use the following formula to calculate the static well volume of groundwater:

$$V = 5.875 \times D^2 \times H$$

Where:
V = Well volume (gallons);
D = Inside well diameter (feet); and
H = Height of groundwater column (feet).

3.0 MONITORING WELL PURGING

Purging monitoring wells prior to sample collection is necessary to remove stagnant groundwater, which may not be representative of in-situ conditions.

Purge parameters including pH, temperature, and specific conductance are monitored / recorded via either flow through cell or via field meters while purging. These purge parameters are measured periodically until purge parameter stabilization is attained according to the following guidelines:

Purge Parameter	Stabilization Criteria
pH	± 0.2 standard pH units for 3 successive readings
Specific Conductance	± 10% for 3 successive readings
Temperature	± 1.0 degree Celsius for 3 successive readings

Additionally, field turbidity will be measured during purging for informational purposes. If non-dedicated pumping equipment is used, the non-dedicated equipment will be cleaned (see Section 5.0, Equipment Cleaning) between use at each monitoring well.

In the event low-flow purging is impractical (limited availability of equipment, etc.), three (3) to five (5) well casing volumes will be purged (if possible) using either pumps or disposable

bailers per the procedures described below. Purge parameters will be monitored / recorded similarly to the method described previously. If a monitoring well purges to a point precluding practical sampling (little or no available groundwater), the monitoring well will be completely evacuated of groundwater and allowed to recover for up to twenty-four (24) hours prior to sampling.

If containerization of purged groundwater is not required, then purged groundwater will be discharged to the ground at least fifteen (15) feet away and downslope of the monitoring well. If containerization of purged groundwater is required, then purged groundwater and spent equipment decontamination water (**Section 5.0**) will be containerized for disposal.

3.1 Low Flow Purging

Low-flow purging (also known as micropurging) is a purging method that has become widely utilized and may be applicable to purging of monitoring wells. This method involves using a pneumatic pump capable of low pumping rates (approximately one (1) liter per minute or less). Low flow purging eliminates the requirement for multiple well casing volume evacuation. Pump discharge rates are regulated and / or controlled to prevent turbulent flow (sample aeration), prevent damage to monitoring well components, and to minimize introduction of sediments into the monitoring well. Monitoring wells purged using low flow purging techniques will be purged as follows:

- Record pH, specific conductance, and temperature.
- Periodically monitor the change in groundwater depth in the well and maintain / adjust the pumping rate to minimize drawdown in the well, to the extent practical.
- Continue pumping at a rate of approximately one (1) liter per minute or less until field parameters have stabilized as described in Section 3.0.

3.2 Pump Purging

When a non-dedicated pump is used to either purge three (3) to five (5) well casing volumes from a well or to evacuate the well of groundwater prior to sampling, purging with non-dedicated pumps will proceed as follows:

- Continue purging groundwater from the well until a minimum of three (3) well casing volumes have been removed and field parameters stabilize.
- Record the actual volume of groundwater removed.
- Continue pumping low-recharge wells until at least one (1) well casing volume has been removed and field parameters have stabilized as described in Section 3.0, or until the well is dry.

3.3 Bailer Purging

When a bailer is used to purge a well, disposable polyethylene bailers will be used along with clean rope (nylon / polyester blend or equivalent). Wells will be purged with bailers as follows:

- Slowly lower the bailer through the water column until the top of the bailer is below the groundwater surface.
- Retrieve the bailer slowly up the water column and out of the well.
- Continue removing groundwater from the well until a minimum of three (3) well casing volumes are purged and field parameters stabilize.
- Record the actual volume of groundwater removed.
- Continue bailing low-recharge wells until at least one well (1) casing volume has been removed and field parameters have stabilized as described in Section 3.0, or until the well is dry.
- If bailing is selected as the purging and sampling method, one (1) disposable bailer will be used per monitoring well.

4.0 GROUNDWATER SAMPLE COLLECTION

Groundwater monitoring wells will be purged and sampled during each monitoring event by purging and sampling the least impacted well first, followed by the next least impacted well, and proceeding until the most impacted well is sampled last. Determination of which monitoring wells are impacted will be based upon recent historical analytical results for each monitoring well and will be performed prior to Herst & Associates, Inc. mobilization to the site.

For low-flow sampling, samples will be collected after achieving stabilization. For pump sampling and bailer sampling, samples will be collected at monitoring wells that yield three (3) to five (5) casing volumes after achieving stabilization. For a monitoring well that purges dry, samples will be collected as soon as the monitoring well has recharged sufficiently and within 24 hours after the monitoring well has been purged. Regardless of sampling methodology employed (bailers or pumps), care will be taken to avoid sample disturbance and to minimize aeration of samples or groundwater in the wellbore (casing and annulus). Bailers will be retrieved slowly through the water column and carefully emptied directly into the appropriate sample container(s).

Entrained air in sample containers or vials will be eliminated when collecting samples for analyses of Volatile Organic Compounds (VOCs).

Samples are collected in pre-preserved containers provided by the analytical laboratory in order of decreasing sensitivity of each analyte to volatilization. The recommended order of sample collection is listed below.

Relative Sensitivity
Of Typical Groundwater Quality Constituents

Sample Container Preparation		Example Analytes
Hydrochloric Acid Preserved*	Decreasing sensitivity ↓	VOCs
Nitric Acid Preserved		Metals
Sulfuric Acid Preserved		Chemical Oxygen Demand
Non-preserved		Nutrients

* Samples to be analyzed for VOCs can be collected in unpreserved containers, but doing so reduces the laboratory holding time from fourteen (14) days to seven (7) days.

Collected samples will be immediately placed in insulated coolers with ice. Samples will be maintained with ice until delivered to the analytical laboratory.

5.0 EQUIPMENT CLEANING

The electronic water level indicator will be decontaminated between each monitoring well. Additionally, if utilized, non-dedicated, non-disposable purging and sampling equipment, including bailers and pumps, will be cleaned between wells.

5.1 Electronic Water Level Indicator Decontamination

The electronic water level indicator described in Section 2.0 will be decontaminated between monitoring wells by thoroughly wiping the graduated tape and water-sensing probe tip with a paper towel wetted with a solution of deionized or distilled water mixed with LiquiNox® (or equivalent) followed by thoroughly wiping the graduated tape and water-sensing probe tip with a paper towel wetted with deionized or distilled water. Wiping the water level indicator will be accomplished during removal of the graduated tape and probe tip assembly from the monitoring well.

5.2 Non-Dedicated Submersible Impeller Pump Decontamination

If a non-dedicated submersible impeller-style pump (e.g. Grundfos Redi-flo 2 or equivalent) is used for purging and sampling, the pump body, pump support cable, and sealed electrical wiring will be decontaminated using a three (3) step wash. The first wash will consist of a vessel containing a solution of deionized or distilled water mixed with LiquiNox® (or equivalent). The second and third washes will consist of vessels containing only deionized or distilled water (e.g. first rinse and second rinse). New, disposable polyethylene groundwater discharge tubing for the impeller-style pump will be used to purge and sample each monitoring well. Groundwater discharge tubing will not be decontaminated or reused.

5.3 Non-Dedicated Submersible Bladder Pump Decontamination

If a non-dedicated submersible bladder pump is used for purging and sampling, the pump body and pump support cable will be decontaminated using a three (3) step wash as

described above. A new, disposable polyethylene bladder, downhole compressed air conveyance tubing, and groundwater discharge tubing will be used to purge and sample each monitoring well. Disposable bladders, downhole compressed air conveyance tubing, and groundwater discharge tubing will not be decontaminated or reused.

6.0 SAMPLE HANDLING

Sample handling and preservation techniques depend on the parameters to be analyzed. Groundwater samples will be collected, preserved and containerized in their order of sensitivity to volatilization (most sensitive to least sensitive). The purpose of sample preservation is to stabilize parameters of concern by retarding chemical or biological changes. Methods of preservation are generally limited to pH adjustment, chemical addition, and cooling. The order of sample collection is as follows: Volatile Organic Compounds (VOCs), samples preserved with nitric acid (metals), samples preserved with sulfuric acid (Chemical Oxygen Demand) and non-preserved samples (nutrients). Proper preservation will help ensure that samples are representative of the groundwater conditions. Field measurements for indicator parameters (pH, temperature, and specific conductance) will be performed on a portion of the sample that has been placed in a separate container, and not submitted for analyses of other parameters. This procedure avoids cross-contamination of laboratory samples by field instrumentation.

Collected groundwater samples will be maintained on ice in insulated coolers until shipment via courier (e.g. Federal Express) or until direct delivery to the laboratory. Chain-of-custody documentation (described in Section 7.0) will be shipped inside a cooler (if multiple coolers are shipped) to the laboratory. Each cooler shipped or directly delivered to the laboratory will be sealed with a Custody Seal (to verify no sample tampering has occurred) over the cooler opening and enclosed by clear packing tape wrapped several times around the cooler.

7.0 SAMPLE DOCUMENTATION AND CHAIN-OF-CUSTODY

Documentation that accompanies groundwater samples to the analytical laboratory generally includes the following:

- Chain-of-Custody (COC) Records: COC records document in a legally defensible manner the history of collection, transport, and transfer of each sample. The individual who is responsible for the samples from the time of collection to the time of sample receipt by the laboratory will be documented in the Chain-of-Custody record. Chain-of-Custody records allow documented tracing of the possession and handling of individual samples from the time of field collection through laboratory analysis. Chain-of-Custody documentation will present collected samples in chronological order.
- Sample Labels – Prevent misidentification of samples. Sample labels will include the site name, sampler's name, well designation, date and time of sample collection, preservative added, and analysis requested.

In addition, field sheets and/or a field log book are used to document information concerning the collection of each sample from each monitoring point in the groundwater monitoring program. Information in the field sheets and/or field log book, described in Section 9.0,

include dates and times of sample collection, well development methods used, weather conditions at the time of sample collection, condition of the wells, and remarks noting any unusual circumstances encountered.

8.0 FIELD QUALITY CONTROL (QC) SAMPLES

Field Quality Control (QC) samples will be collected to verify that sample collection and handling procedures were properly performed and that the procedures have not affected the quality of the groundwater samples. Field QC samples will consist of Trip Blank samples, Field (atmospheric) Blank samples, Equipment Blank samples, Field Duplicate samples, and potentially Matrix Spike / Matrix Spike Duplicate samples.

8.1 Trip Blank Samples

Trip blanks will be analyzed for VOCs only and consist of deionized water samples prepared in appropriate containers by the laboratory and received prior to mobilizing to the site. The trip blank samples then accompany the groundwater samples back to the laboratory for analysis. Preparation and analysis of trip blanks for VOCs indicates if site samples have been affected by transport-induced contamination, and can also be used to assess potential laboratory contamination. One (1) trip blank will be included for analysis with each sample shipment containing samples for VOC analysis during each monitoring event.

8.2 Field Blank Samples

Field (atmospheric) blank samples consist of deionized water samples collected in containers at the site during the sampling event and under the same environmental conditions as the monitoring well samples. The analysis of field blank samples can detect the influence of ambient site conditions that may bias the sample suite. One (1) field blank sample will be collected per twenty (20) or fewer collected groundwater samples (minimum 5% sample coverage) during each monitoring event.

8.3 Equipment Blank Samples

If non-dedicated, non-disposable purging and sampling equipment is used, the effectiveness of cleaning and decontamination procedures will be verified by the collection and analysis of equipment blank samples. After equipment decontamination is performed, an equipment blank sample is prepared by filling the purging and sampling device(s) with deionized water, followed by collection of the water into sample containers. Equipment blanks will be handled and analyzed in the same manner as collected groundwater samples. Equipment blank samples are not required if either dedicated purging and sampling equipment is used or disposable equipment (e.g. disposable bailers) is used. If non-dedicated purging and sampling equipment (e.g. non-dedicated pump) is used, one (1) equipment blank will be collected per twenty (20) or fewer collected groundwater samples (minimum 5% sample coverage) during each monitoring event.

8.4 Field Duplicate Samples

A field duplicate sample is collected from a monitoring well concurrently with collection of the primary groundwater sample from that well, and in an identical fashion. Analysis of field

duplicate samples provides an indication of the variability in analytical results associated with sample collection procedures and laboratory procedures. One (1) field duplicate sample will be collected per twenty (20) or fewer collected groundwater samples (minimum 5% sample coverage) during each monitoring event.

8.5 Matrix Spike / Matrix Spike Duplicate Samples

Matrix Spike / Matrix Spike Duplicate (MS / MSD) samples are collected from a monitoring well concurrently with collection of the primary groundwater sample from that well, and in an identical fashion. Alternatively, the analytical laboratory may elect to split a received primary groundwater sample into multiple portions and perform MS / MSD analysis on a separate portion of the sample. Once received by the analytical laboratory, a known quantity of target analyte is added to the MS / MSD samples by the laboratory analyst prior to analysis. Analysis of MS / MSD samples provides an indication of the effects of the groundwater matrix on analytical results. One (1) MS / MSD sample pair will be collected per twenty (20) or fewer collected groundwater samples (minimum 5% sample coverage) during each monitoring event.

9.0 FIELD SHEETS / FIELD LOG BOOKS

Field sheets (also called Field Information Logs) and / or field log books will be maintained during each groundwater sampling event. Field Information Logs / field log books will include field observations and well developing, well purging, and well sampling details. Additionally, the following information will be documented on Field Information Logs / field log books:

- Site name;
- Site well designation;
- Sample collector's name and affiliation (i.e., landfill, laboratory, or contract personnel);
- Weather conditions encountered during sampling (such as rain) that could affect sample quality;
- Pre-purging depth to water, measured from top of inner casing;
- Total depth of well installation, measured from top of inner casing;
- Wetted casing or borehole volume;
- Starting and ending times for well purging;
- Purging rate (if low-flow purging or pump purging);
- Depth to water measurement after sample collection; and,
- Sample collection date and time.

A blank example field sheet is provided as **Appendix C**.

Appendices

Appendix A

Example Groundwater Elevation Measurements Form

HERST & ASSOCIATES, INC.®

Global Presence
Personal Attention

GROUNDWATER ELEVATION MEASUREMENTS

Site:

Personnel:

Well ID	Date	Time	Depth to Water (ft)	Depth to Water Previous Event (ft)	Total Depth (ft)	Total Depth Previous Event (ft)	Notes

Page _____ of _____

Appendix B

Example Monitoring Well Condition Report

HERST & ASSOCIATES, INC.®

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Personal Attention

GROUND WATER MONITORING WELL CONDITION REPORT

Facility: _____ Well ID: _____ Date: _____

Access:

Accessibility: Truck Accessible _____ ATV/Mule Accessible _____ Walking Access ONLY _____

Note: Indicate accessibility for wet conditions.

Vicinity of well clear of weeds and/or debris: Yes _____ No _____

Remarks: _____

Concrete Pad:

Any issues with concrete pad? No _____ Yes _____ If yes, then explain below.

Presence of depressions or standing water around well: Yes _____ No _____

Remarks: _____

Protective Outer Casing: Material: _____

Note: For ANY indication of Damaged, please provide written description

Condition of Protective Casing: Good _____ Damaged _____ Missing _____

Condition of Exterior Well ID Markings: Good _____ Damaged _____ Missing _____

Condition of Locking Cap: Good _____ Damaged _____ Missing _____

Condition of Lock Good _____ Damaged _____ Missing _____

Condition of Weep Hole: Good _____ Damaged _____ Missing _____

Remarks: _____

Well Riser: Material: _____

Note: For ANY indication of Damaged, please provide written description

Condition of Riser: Good _____ Damaged _____

Condition of Riser Cap: Good _____ Damaged _____ Missing _____

Measurement Reference Point: Good _____ Damaged _____ Missing _____

Remarks: _____

Dedicated Purging / Sampling Device Present?

Yes _____ No _____ If yes, what type of device? _____

Condition: Good _____ Damaged _____ If Damaged, please provide written description.

Remarks: _____

Field Certification: _____

Signed Title Date

Herst & Associates, Inc. 4630 South Highway 94 - North Outer Road, St. Charles, MO 63304 (636) 939-9111 (636) 939-9757 fax

Appendix C

Example Field Information Log

HERST & ASSOCIATES, INC.®

Global Presence
Personal Attention

FIELD INFORMATION LOG Part 1

Facility: _____ Sample Point ID: _____

Location: _____ Sampler(s): _____

Sample Matrix: _____ _____

Top of Casing (ft, msl) _____

PURGE INFORMATION:

Method of Well Purge: _____ Dedicated Equipment: Yes _____ No _____

Date/Time Initiated: _____ Casing Diameter (inches): _____

Initial Water Level (feet): _____ One Casing Volume (gal): _____

Initial Water Level Previous Event (feet): _____ One Casing Volume Previous Event (gal): _____

Ground Water Elevation (ft, msl): _____ Total Volume Purged (mL): _____

Ground Water Elevation Previous Event (ft, msl): _____ Purged Dry?: Yes _____ No _____

Well Total Depth (feet): _____ Water Level after Purge (feet): _____

Well Total Depth Previous Event (feet): _____ Date/Time Completed: _____

PURGE DATA:

Time	Purge Rate (Hz / gpm)	Cumulative Volume (gal)	Temp (°C)	pH (std units)	Conductivity (µS = µmhos/cm)	Turbidity (NTU)	Water Level (feet)	Notes

HERST & ASSOCIATES, INC.®

Global Presence
Personal Attention

FIELD INFORMATION LOG Part 2

SAMPLING INFORMATION: Sample Point ID: _____

Sampling Method: _____ Dedicated: Yes _____ No _____

Water Level @ Sampling (ft): _____ Sample Collection Sequence #: _____ of _____

Parameters: Annual: ___ Semi-Annual: ___ Quarterly: ___ Monthly: ___ Other: _____

SAMPLE DATA:

Time & Date	Sample Rate	Temp (°C)	pH (std units)	Specific Conductance (µS = µmhos/cm)	Turbidity (NTU)	Other	Notes
	VOC:						
	Other:						

INSTRUMENT CALIBRATION DATA:

Start of day: (Date/Time) _____

End of day: (Date/time) _____

Turbidity Meter: _____

Turbidity Meter S/N: _____

pH Meter: _____

pH Meter S/N: _____

Conductivity Meter: _____

Conductivity Meter S/N: _____

Purging Event			Sampling Event		
Start of day	End of day		Start of day	End of day	
		NTU std = 0.02			NTU std = 0.02
		NTU std = 10.0			NTU std = 10.0
		NTU std = 1,000			NTU std = 1,000
		µS std = 84.0			µS std = 84.0
		µS std = 1,413			µS std = 1,413
		µS std = 12,880			µS std = 12,880
		pH std = 4.01			pH std = 4.01
		pH std = 7.00			pH std = 7.00
		pH std = 10.00			pH std = 10.00

Other Calibration: _____

GENERAL INFORMATION:

Weather Conditions @ Sampling: _____

Sample Characteristics: _____

COMMENTS AND OBSERVATIONS:

_____

_____

_____

_____

Date: _____ By: _____ Title: _____

Company: **Herst & Associates, Inc.**